RATE AND DARK ADAPTATION
AS DETERMINANTS OF
APPARENT MOTION

By

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CHAPTER I

INTRODUCTION

A physiological basis of apparent motion is to be investigated in terms of an antecedent retinal process, dark adaptation, and a concomitant retinal process, stimulation rate.

Two current visual theories, Hecht's photochemical theory (7) and Motokawa's theory (18), are to be reviewed for an explanatory principle of motion perception, especially of the kind commonly designated apparent motion.

Hecht's photochemical theory states that the first reaction which follows light stimulation results in the production of catalyzers which control the velocity of a second chemical reaction. The latter reaction, in turn, initiates the nerve impulse. The second chemical reaction, the breakdown of rhodopsin, follows the kinetics of a monomolecular reaction (8). This indicates the simple reaction is one of a direct chemical nature, not a physical one, such as diffusion. Lythgoe (15) showed that the bleaching of rhodopsin occurs in several steps: first, the production of transient orange, then yellow, and finally, upon further bleaching, a colorless substance. During dark adaptation in the normal eye there is a regeneration curve of rhodopsin which corresponds to a curve of two uncombined substances at any given moment producing a

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third compound from these two simpler ones at a constant temperature.
The adaptation rate is important and is a function of the degree of
change in brilliance which influences the concentration of the
previously identified compounds. Light adaptation is more rapid than
dark adaptation. When colored lights are used it is found that
adaptation to red is more rapid than to any other color (1). If the
degree of regeneration of visual purple is compared to the degree of
retinal sensitivity there is no increase in retinal sensitivity until
visual purple has regenerated to nearly half its original value (5).
Granit (6) is of the opinion that only a small fraction of the visual
purple, that which occurs in the surface film of a rod, not the larger
store within, is needed for excitation. This means that the regener-
ation of visual purple begins and proceeds in advance of the beginning
of real dark adaptation and that there is not a direct correlation
between the regeneration of visual purple and dark adaptation. Thus,
the increase in retinal sensitivity cannot be accounted for in terms
of an increasing concentration of visual purple in the light of
electro-retinographic investigations (11). It becomes necessary to
postulate a neural mechanism in the retina (22). A mechanism may
involve a summation or inhibition of neural activity in terms of area
and time. During dark adaptation the change in excitation may
increase the area of the retina from which neural impulses converge
upon the same afferent tract. After the first stimulation has ceased
to exert its effect a summation mechanism may extend the duration of
a state of raised excitability. The locus of a mechanism of summation
or inhibition is presumably in the synaptic membranes of the neural

network.

Motokawa's theory (18) is a general theory which relates physiological processes to perceptual experiences involved in real and apparent motion. He (19) recently provided experimental evidence which indicates some common retinal conditions induced under real and apparent motion. Motokawa and Ebe (20) offered the hypothesis of retrograde suppression as a possible explanation.

A full understanding of this hypothesis is important and this may be facilitated by reviewing some of the work that led Motokawa to postulate it. He used the phosphene technique to obtain his results. This technique consists of ascertaining the minimal amount of electric current that must pass through the eyeball in order to produce the experience of light. A direct current is passed through the eyeball following photic stimulation and thereby capitalizes on the hyper-normal excitability that is characteristic of neural recovery following photic stimulation. The results obtained are therefore specific to the stimulated region rather than the entire retina.

When a stationary object, a patch of yellow light, is flashed on the retina and the area immediately outside of the stimulated area is tested, the excitability curve is characteristic of a blue light curve. In other words, the area surrounding an area of stimulation is complementary to the area stimulated.

When a real object is moved in front of an eye, a path of stimulation across the retina appears. This path is not complementary to the stimulus but identical to it. Therefore, in the perception

of real motion, a retinal gradient is created and this gradient is of such a nature that it is identical with, rather than complementary to, the moving stimulus. This means that in real motion there is an intervening path between the beginning and the end of stimulation and this path is identical in nature with the stimulus.

However, apparent motion is produced between two discrete points of alternating stimulation that are arranged in temporal order to create the phenomenal experience of a single moving light. Motokawa and Ebe (20) undertook to determine the type of retinal gradients that existed during the experience of apparent motion. They found that, whenever the two stimuli appeared to be simultaneous or alternating, the intervening retinal area was complementary to the stimuli. Here is an analogy to the perception of a single stationary object. Whenever the two stimuli were arranged in temporal order to produce the phenomenal experience of motion, the intervening retinal area was identical with, rather than complementary to, the stimuli. This situation is analogous to a perception of a single moving object. A fusion of two separate stimuli may be achieved in the layers of neurons constituting the retina. This fusion may be due to retinal induction and this retinal induction is presumably a physiological state prevailing in synaptic membranes of the retinal network.

Brown (2) believed that the perceptual factors producing the perception of apparent motion are intimately related to those factors producing real motion. He therefore believed that a psychological theory of perception of all motion can be related to some common basis. Brown's inference was contrary to the original hypotheses of

Wertheimer (26) and Korte (13). The latter two Gestalt psychologists indicated a different basis for real motion. Wertheimer provided the first experimental recognition of the problem. Korte used the results of his own experimentation and those of Wertheimer to establish a set of parameters between the stimulus dimension and the response. Koffka and Cermak (12) found it necessary to supplement these earlier statements with a series of "zone laws" which were applied to boundary conditions. Koffka believed that with the accumulation of experimental evidence there would ultimately be an evolution and synthesis of the parameters producing apparent motion.

More recently Gibson (4) stated that apparent motion stimulation differs from so-called "real" stimulation only in being discontinuous when the latter is continuous. Apparent motion and a moving object are manifestly different.

Saucer (23), and Horne and Saucer (10), used dark adaptation as an experimental variable and rate as a constant in the investigation of the dependent variables of mean duration of beta and the number of reversals. The trends of mean duration were inconsistent for rates of 2 and 4 per second.

Certain physiological effects of alternating stimulation at selected rates and additional effects of dark adaptation have been related to the physiological state prevailing in synaptic membranes of the retinal network.

Hypotheses can now be drawn based upon the assumption that the synaptic membranes involved in changes in rate and dark adaptation may produce a systematic variation in the perception of apparent

motion. This phenomenon of beta motion has a physiological basis and therefore is independent of the observer. Beta motion is a type of apparent motion which is produced by the summation of two discrete areas of retinal stimulation. This summation may occur within the retina or at other synaptic levels of the visual system (16).

Apparent motion can be considered as a product of two functions. One may be related to peripheral events at a retinal level and the other to a central process (27). The aim of this investigation is to analyze some of the retinal contributions to apparent motion.

CHAPTER II

APPARATUS AND PROCEDURE

Apparatus

The apparatus consists of (1) an electronic switch, (2) a stimulus light panel, (3) a light adaptation panel, (4) a subject's headrest, and (5) a constant speed recorder operated by a telegraphic key. These are illustrated in Figure 1.

The electronic switch controlled the flash rate, light intensity, and duration of light and dark periods. The sources of light in the stimulus light panel were two Sylvania 1130B electronic tubes. "The lights were fired by a square wave having an extremely short rise time. This, taken in connection with the short ionization time of the gas, insures a minimal time interval between the appearance of one stimulus and the extinction of the other stimulus. The bulbs were placed in the plate circuit of a 6SH7 rf pentode. The use of pentode controller tubes permits adjusting the plate current by varying the screen grid voltage. Essentially, the 6SH7 functions as a wide band grounded grid amplifier. The cathode resistor is common to the cathode resistor of one triode unit of a 6SN7. The two halves of the 6SN7 are connected in a multi-vibrator circuit, which generates the square waves used as gating signals for pentodes. Cathode coupling eliminates wave distortion and time delay usually associated with RC coupling at low frequencies" (23).

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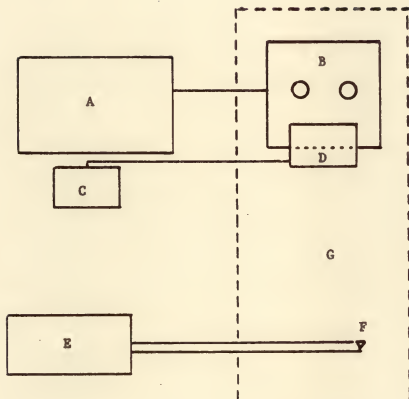
Legend:

A. - Electronic Switch
B. - Stimulus Light Panel
C. - Variable Rheostat
D. - Light Adaptation Panel
E. - Gerbrands Recorder
F. - Telegraph Key
G. - Subject's Compartment

Fig. 1. Block diagram of apparatus

The light from both Sylvania tubes was filtered by two sets of red filters with a dominant wave length of 640 mu. The apparent brightness of each red light was 0.14 millilamberts at the eye position, one meter from the apertures. At this distance the monocular visual angle of each light was 1° 05'. The binocular field of both lights subtended 5° 50'.

A headrest provided a fixed position for the subject at the one-meter distance.

Directly beneath these lights was placed the light adaptation panel which consisted of a homogeneous field, approximately 7x9 inches, of white light. It was illuminated by two tubular-shaped 40 watt incandescent bulbs which together provided a homogeneous illumination of 2.9 millilamberts.

The subject's compartment including the apparatus was painted a flat black. Black curtains were arranged in such positions that the only illumination came from the white light panel during the light adaptation period, or the stimulating lights during the observation period which followed dark adaptation. Finally, the room was painted a flat black and light sealed.

The recording apparatus was a Gerbrand, constant speed, four-channel recorder. This recorder was placed in a sound proof box and was tripped by a telegraph key that was operated by the subject.

In each of the experiments the sequence of light adaptation, dark adaptation, and recording was held constant.

Procedure

Four experiments were performed using the independent variables of dark adaptation time, flash rate, and subjects. The design of the experiment is shown by the following paradigm.

Experiment	Dark Adaptation Period (Min.)	Flash Rate (Flash Per Second)	Identifi- cation of Subjects
I	1, 4, 8, 12	1.4, 2.2, 3.0	1-12 unselected
II	0, 1, 2, 3,	1.4, 2.2, 3.0	1-12 same
III	0, 2, 4, 6	0.7, 1.0, 1.4	13-24 naive
IV	0, 2, 4, 6	0.7, 1.0, 1.4	25-36 experienced

The subjects in this experiment consisted of twenty-eight males and five females whose ages ranged from 21 to 39 years, with a mean age of 27.3 years. All subjects were students at the University of Florida, Gainesville, Florida.

In every experiment each subject was brought to the experimental room containing the apparatus and was given a brief preliminary training period. After the subject was seated and his head placed in the head-rest the following verbatim instructions were read to the subject:

"I am going to demonstrate to you a number of different rates. At each of these rates I want you to tell me what you 'see'."

When the subject spontaneously reported seeing a single light, burning continually, moving back and forth, these instructions were read:

"When you see the thing you have just described you are to press the key down and keep it down for the length of time you

see it. When you don't see it, you are to let the key up. Now, when you enter you will see a light panel 7x9 inches. You are to look at it for a period of two minutes, at the end of which the light will be turned off. Following a variable period of darkness you will be asked to close your eyes so the apparatus may be activated. Shortly thereafter you will be asked to open your eyes. As you open them quickly press the key three times."

"You have observed that the movement of a single spot may not always be present. Remember that during the recording session you are asked to press the key down during the time that such motion may be present. Release it when other conditions appear. Do not talk to the experimenter. Please do not remove your face from the headrest."

The rates of stimulation and dark adaptation times were presented in a systematically balanced order. This order placed each subject in every experimental situation with no two subjects receiving the same order of presentation.

The observers in Experiment I reported their observations for a three-minute period. The observers in the ensuing experiments reported their observations under each combination of fixed variates for one-minute periods.

The subjects in Experiments I and II were unselected as to their previous experience in the experimental situation. The subjects in Experiment III were selected for their lack of experience in the experimental situation whereas those in Experiment IV were selected because of their previous experience in perception. Three subjects

in this group were drawn from Experiments I and II.

In summary each subject observed the pre-dark adaptation light for two minutes, waited the required length of time in the dark, and then recorded for an observation period. Twelve separate sequences of presentation of the independent variables were systematically arranged and randomly assigned to each of the twelve subjects in each experiment.

CHAPTER III

RESULTS

The results were analyzed with a three-dimensional analysis
of variance: dark adaptation x rate x subjects (14). The design was
a mixed model in which dark adaptation and rate were fixed variables
and subjects were random variables in all experiments (25). Experi-
mental replications were planned with some of the fixed variates
altered. Dark adaptation periods were shortened in Experiments II,
III, and IV. Flash rates in Experiments III and IV were slower to
lower the rate of stimulation. Subjects in Experiments III and IV
were selected from a student population that differed in the degree
of experience in the experimental situation.

The quantitative measure obtained from the subject's recording
was the mean duration of apparent motion. This was obtained by
dividing the total amount of motion perceived by the number of per-
ceptions of motion occuring during the recording period. This average
length of the perception of apparent beta motion was selected as the
essential dependent variable.

Table 1 presents the results of an analysis of variance applied
to the mean duration of beta motion at the prescribed dark adaptation
times and flash rates. These results were obtained from three-minute
recording sessions. The $\underline{F}$ ratios obtained indicated that: rate of
stimulation was significant at the .005 level, and dark adaptation

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TABLE 1

ANALYSIS OF VARIANCE FOR THE PERCEPTION OF APPARENT MOTION.
DARK ADAPTATION 1, 4, 8, and 12 MINUTES. FLASH RATE
1.4, 2.2, 3.0 FLASHES PER SECOND
12 UNSELECTED SUBJECTS

Source of Variance	Sum of Squares	df	Mean Square	F Ratio	F	p
1. Dark Adaptation Time (D)	1,634.488	3	544.829	D/DS	2.24	-
2. Rate (R)	43,675.188	2	21,837.594	R/RS	6.94	.005
3. Subjects (S)	51,341.248	11	4,667.386			
4. D x R	2,586.775	6	431.129	DR/DRS	2.32	.05
5. D x S	8,023.141	33	243.125			
6. R x S	69,204.788	22	3,145.672			
7. D x R x S	12,265.204	66	185.836			
8. TOTAL	188,730.832	143				

level was not significant. The DR/DRS interaction was significant
at the .05 level.

Figures 2 and 3 present, respectively, (1) the mean duration
of apparent motion and dark adaptation time, with rate as a para-
meter, and (2) the mean duration of apparent motion and rate, with
dark adaptation as a parameter. Stimulation rate effects were signi-
ficant. Dark adaptation was not significant. Within the first four
minutes and at the slower rate the rise in mean duration was greatest.
In other words, increasing the dark adaptation time beyond four
minutes did not change the mean duration of apparent motion but
increasing the fixed variable rate did significantly reduce the mean
duration.

Table 2 contains the results of an analysis of variance
applied to the mean duration of beta movement at the prescribed dark
adaptation times and flash rates. These results were obtained from
a one-minute recording session. The obtained F ratios indicated that:
rate of stimulation was significant at the .001 level, and dark
adaptation time was not significant. The DR/DRS interaction was not
significant.

Figures 4 and 5 present, respectively, (1) the mean duration
of apparent motion and dark adaptation time, with rate as a parameter,
and (2) the mean duration of apparent motion and rate, with dark
adaptation as a parameter. The effects of the various rates on the
average length of the perception of apparent beta motion were
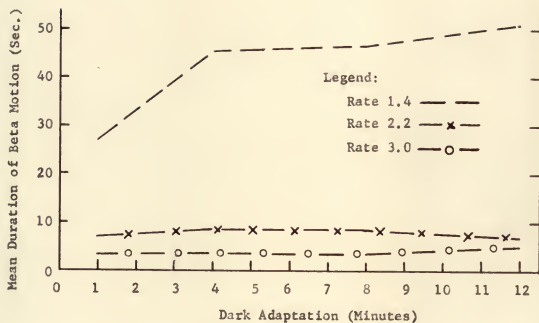separate. Rate 1.4 showed a marked trend toward increasing the

EXPERIMENT I

Fig. 2. Mean duration of beta motion as a function of dark adaptation.
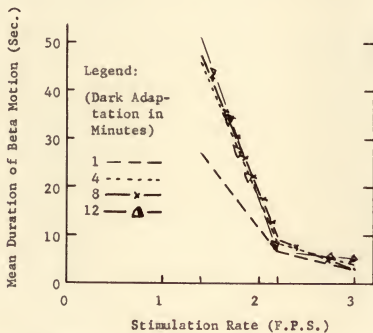
Fig. 3. Mean duration of beta motion as a function of rate.

TABLE 2

ANALYSIS OF VARIANCE FOR THE PERCEPTION OF APPARENT MOTION.
DARK ADAPTATION 0, 1, 2, and 3 MINUTES. FLASH RATE
1.4, 2.2, 3.0 FLASHES PER SECOND.
12 UNSELECTED SUBJECTS

Source of Variance	Sum of Squares	df	Mean Square	F Ratio	F	p
1. Dark Adaptation Time (D)	427.760	3	142.587	D/DS	1.80	-
2. Rate (R)	10,941.445	2	5,470.722	R/RS	18.39	.001
3. Subjects (S)	14,640.096	11	1,330.918			
4. D x R	415.728	6	69.288	DR/DRS	0.93	-
5. D x S	2,619.543	33	79.380			
6. R x S	6,542.791	22	297.400			
7. D x R x S	4,904.312	66	74.308			
8. TOTAL	40,491.675	143				

EXPERIMENT II

Fig. 4. Mean duration of beta motion as a function of dark adaptation.

Fig. 5. Mean duration of beta motion as a function of rate.
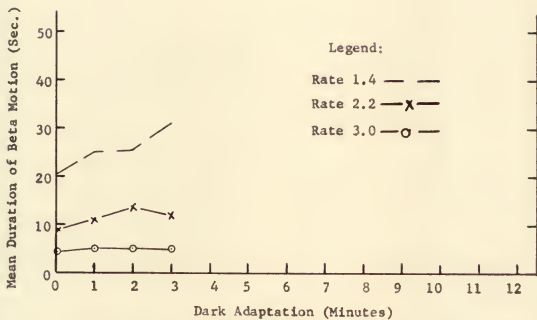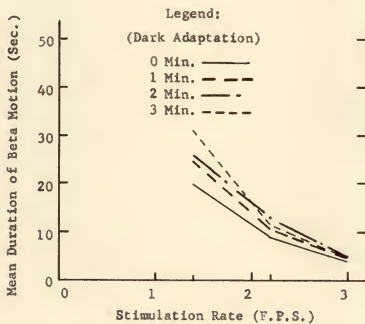
average duration with increasing dark adaptation. Rate 2.2 showed this trend to a much lesser degree and rate 3.0 was unaffected by increasing dark adaptation time.

In Table 3 are the results from naive subjects during a one-minute recording session. An analysis of variance was applied to the mean duration of beta motion at the prescribed dark adaptation times 0, 2, 4, and 6 minutes and at slow flash rates 0.7, 1.0, and 1.4. The F ratios indicated that at the reduced rate of stimulation this variable was not significant, and dark adaptation time was not significant. The DR/DRS interaction was not significant.

Figures 6 and 7 indicate these nonsignificant effects on the mean duration of apparent motion.

Table 4 presents the results of an analysis of variance applied to the mean duration of beta motion at the prescribed dark adaptation times and flash rates with experienced subjects during a one-minute recording session. The F ratios obtained indicated that: rate of stimulation was significant at the .01 level and dark adaptation was not significant. The DR/DRS interaction also was not significant.

Figures 8 and 9 present, respectively, (1) the mean duration of apparent motion and dark adaptation time, with rate as a parameter, and (2) the mean duration of apparent motion and rate, with dark adaptation as a parameter. Rate 0.7 showed a nonsignificant increase in mean duration for two minutes'dark adaptation; any further dark adaptation produced no effect. Rate 1.0 showed a nonsignificantly increasing mean duration with increasing dark adaptation times. Rate 1.4 showed little change with increasing dark adaptation. The effects

TABLE 3

ANALYSIS OF VARIANCE FOR THE PERCEPTION OF APPARENT MOTION.
DARK ADAPTATION TO 0, 2, 4 and 6 MINUTES. FLASH RATE
0.7, 1.0, 1.4 FLASHES PER SECOND.
12 NAIVE SUBJECTS

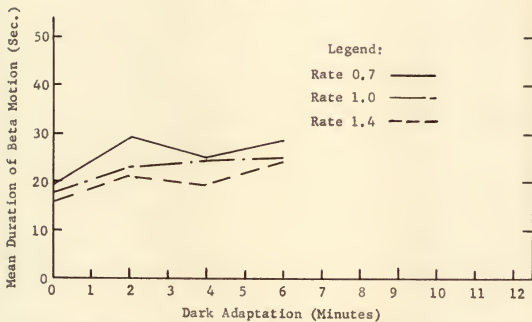| Source of Variance	Sum of Squares	df	Mean Square	F Ratio	F	p
1. Dark Adaptation Time (D)	1,345.656	3	448.552	D/DS	2.25	-
2. Rate (R)	689.282	2	344.641	R/RS	0.89	
3. Subjects (S)	16,759.211	11	1,523.565			
4. D x R	198.694	6	33.116	DR/DRS	0.21	-
5. D x S	6,566.767	33	198.993			
6. R x S	8,523.053	22	387.411			
7. D x R x S	10,460.320	66	158.490			
8. TOTAL	44,542.983	143				

EXPERIMENT III

Fig. 6. Mean duration of beta motion as a function of dark adaptation.
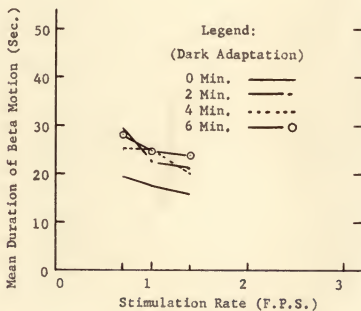
Fig. 7. Mean duration of beta motion as a function of rate.

TABLE 4

ANALYSIS OF VARIANCE FOR THE PERCEPTION OF APPARENT MOTION.
DARK ADAPTATION TO 0, 2, 4 and 6 MINUTES. FLASH RATE
0.7, 1.0, 1.4 FLASHES PER SECOND.
12 EXPERIENCED SUBJECTS

Source of Variance	Sum of Squares	df	Mean Square	F Ratio	F	p
1. Dark Adaptation Time (D)	445.994	3	148.665	D/DS	1.78	-
2. Rate (R)	2,328.467	2	1,164.233	R/RS	6.11	.01
3. Subjects (S)	33,041.421	11	3,003.766			
4. D x R	371.980	6	61.997	DR/DRS	0.85	-
5. D x S	2,754.791	33	83.479			
6. R x S	4,190.338	22	190.470			
7. D x R x S	4,812.634	66	72.919			
8. TOTAL	47,945.625	143				

EXPERIMENT IV

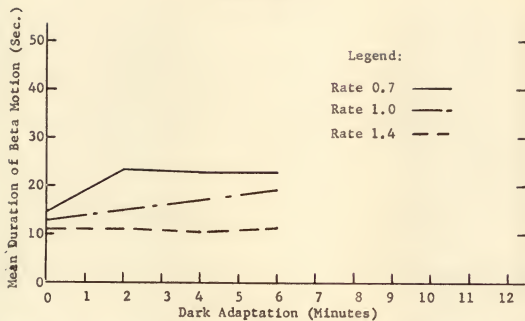Fig. 8. Mean duration of beta motion as a function of dark adaptation.
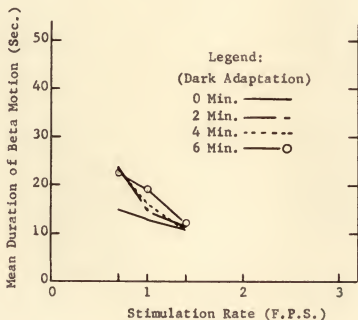

Fig. 9. Mean duration of beta motion as a function of rate.

of dark adaptation at the various rates were variable and failed to show a consistent trend.

CHAPTER IV

SUMMARY AND DISCUSSION

This experimental investigation was designed to determine
the main effects and the interactions produced by changes in rate of
stimulation and duration of dark adaptation on the perception of
apparent motion in a characteristic pattern known as beta motion.
Since it was previously shown that instructions may be a significant
variable (21), instructions were kept constant at all times in this
investigation. Four related experiments were included in this study.
One fixed variate, stimulation rate, was found to be significant in
Experiments I, II, and IV, and not significant in Experiment III.
The difference in results may not be readily accounted for. In other
research (24) rate has been significant consistently within those
particular variations of rate. In this analysis when the range of
rate variation was narrow and when the rate was slow, rate changes
failed to produce a significant modification of the mean duration of
beta motion in the observations of the inexperienced subjects. For
this latter group, the duration of beta perception was apparently more
readily stabilized and not subject to experimental manipulation at the
slow rates 0.7 to 1.4 and dark adaptation periods up to 6 minutes.
The mean durations were consistently, if not always significantly,
longer at the slow rates. The suggestion is apparent that a better

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stability of perception may resist certain experimental manipulation.

Since the rate variable has fairly consistently been reported to be a determinant of the mean duration of beta motion and has consistently been a significant variable at faster rates, 1.4 to 3 in this investigation, an explanation is attempted. The average duration in the perception of beta motion was reduced significantly as stimulation rate increased. Stability of beta perception, as measured by the mean duration, appears to be inversely related to rate within the range of rates used. Horne (9) has found, for two lights alternately flashing at distances separated by the interpupillary distance at rates of 20.55 flashes per second (SE = 0.23), fusion in the lights each clearly separated from the other and no motion of the beta type. At a lower rate, 3.96 flashes per second (SE = 0.03), a threshold in the form of an upper limit of beta motion was obtained. Below the motion-fusion threshold the motion was smoother and it was optimal at 2.99 flashes per second (SE = 0.03) for these normal Ss, male nursing assistants of the Gulfport V. A. Center.

Some form of fusion hypothesis (20) was offered as an important factor for optimal apparent movement. Motokawa and Ebe (20) placed a locus of motion at the retinal level and their position contradicts the older notions of Koffka (12), and Marbe (17) in that the Gestalt writers have emphasized the central locus for perception of motion. In one recent study, Wilson (27) correlated a measure of resting brain rhythms and an independent measure of optimal motion. With normal college Ss he obtained for each S the optimal rate of stimulation for beta perception. The mean rate which he obtained

was 1.94. His standard error was 0.10. From the electroencephalograms each S's alpha frequency was calculated. It was found that alpha frequency was negatively correlated, -0.43 ($p < .05$), with optimal beta rate. If Ss with fast alpha rate select slow optimal beta rates and Ss with slow alpha select faster beta rates, the central resting rhythm is not easily seen as a pacemaker for beta perception. Alpha frequency and mean duration of beta correlated 0.51 ($p < .01$). Ss with slow alpha frequency reported beta for shorter mean durations. Central processes of this type have not produced a scanning process (3), a visual attention hypothesis (3), or a movement perception hypothesis (3). A fusional mechanism may be more particularly identified with a peripheral mechanism (20).

It was one of the purposes of this investigation to attempt to establish a locus of a peripheral mechanism and to determine whether dark adaptation would modify the stability of the beta type of perception. In this study for the durations longer than three minutes dark adaptation was not an effective variable. Even the short periods of dark did not change significantly the mean duration of beta motion. In some previous work conflicting trends (see Figure 10) were reported for a rate of 2 flashes per second (10) and 4 flashes per second (23, 10). The mean duration increased from 0 to 5 minutes of dark adaptation at a rate of 2 (10), but at a rate of 4 the mean duration decreased during the 0 to 5 minute period of dark adaptation (23). The difference in duration after zero time for dark adaptation was insignificant for these rates. In the present study for zero dark adaptation the mean durations varied for different rates. The difference in

SUMMARY

Legend:

Graph	No. Ss.	Investigator	Rate FPS
□	6	Saucer	4.0
	2	Horne & Saucer	4.0
○	12	Wilson	3.0
×	12	Wilson	2.2
	2	Horne & Saucer	2.0
	12	Wilson	1.4
	12	Wilson	1.0
	12	Wilson	0.7

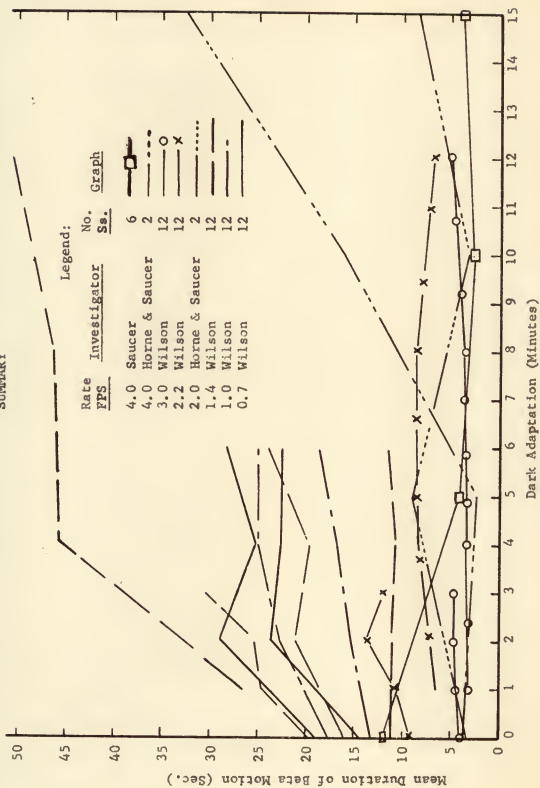Mean Duration of Beta Motion (Sec.)

Dark Adaptation (Minutes)

Fig. 10. Mean duration of beta motion as a function of dark adaptation.

technique may account for the discrepancy in results. In a simple randomized design Horne and Saucer employed a 10° field with a 50 cm distance of observer. The present study used a 5° 50' field and the distance was 1 meter. In the present investigation it was planned to restrict movement to a central area in the field and possibly to foveal vision even though no definite fixation point was given. From the several investigations it can be concluded that faster rates of retinal stimulation are likely to produce unstable beta perception.

CHAPTER V

CONCLUSIONS

From the four experiments, which constitute an investigation
of the effects of changes in rate of stimulation and duration of dark
adaptation on apparent motion, the following conclusions are made.

For flash rates selected from a middle range for the
stimulation of optimal beta motion, the rate was a significant
variable in determining the mean duration. For the very slow rates,
the rate did not significantly change the mean duration for the
inexperienced Ss, but for the experienced Ss rate was significant.
For the fast rate near the upper limit of beta motion, the mean
duration was small and it was not subject to rate manipulation. The
fast rate primarily lowered the duration of beta motion and made beta
perception unstable.

A dark adaptation period following exposure to a moderate
illumination of 2.9 millilamberts appeared to sensitize the retina.
Changes in dark adaptation did not significantly change the mean
duration of beta motion.

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BIOGRAPHICAL ITEMS

Santford Russell Wilson, Jr., was born at Miami, Florida, on March 23, 1927. He served two years in the United States Navy as a hospital corpsman attached to the VI Marine Division.

He returned to the University of Florida where in 1949 he received the degree of Bachelor of Science, with honors.

He entered the Graduate School of the University of Florida in September, 1950, and received the degree of Master of Arts in January, 1955.

At the present time he has satisfactorily completed his first year in the College of Medicine, University of Florida. He is currently a Medical Student Research Fellow. He is also engaged in work leading to the degree of Doctor of Philosophy in Psychology.

He is an associate member of the Florida Psychological Association, Southern Society of Philosophy and Psychology, Southeastern Psychological Association, and the American Psychological Association.

This dissertation was prepared under the direction of the chairman of the candidate's supervisory committee and has been approved by all members of the committee. It was submitted to the Dean of the College of Arts and Sciences and to the Graduate Council and was approved as partial fulfillment of the requirements for the degree of Doctor of Philosophy.

August 10, 1957

Stan E. Wimberly
Dean, College of Arts and Sciences

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Dean, Graduate School

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